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ASPECTS OF TREATMENT*

The direct perfusion of surgical wounds with local anaesthetic solution: an approach to postoperative pain?

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Summary
A simple technique of wound perfusion with bupivacaine (Marcain) which provides sustained postoperative analgesia is described. No complications nor side effects related to toxicity, hypersensitivity, infection, or impaired wound healing were encountered. Postoperative pain was reduced and analgesic requirements were significantly lower in patients undergoing both intermittent ($P<0.01$) and continuous ($P = 0.1$) wound perfusion (Student t test). Perfusion with isotonic saline was also found to be effective. This may represent a true therapeutic effect attributable to the removal or dilution of pain mediating substances in the wound.

Introduction

Postoperative pain following abdominal surgery is conventionally controlled by the administration of opiates or their derivatives. These potent, centrally acting agents may produce respiratory and cardiovascular depression, or may interact dangerously with other drugs such as mono-amine-oxidase inhibitors. The concept of specific regional anaesthesia is, therefore, appealing but neither intercostal nerve block nor epidural anaesthesia have gained widespread acceptance. A possible alternative might be the direct perfusion of the surgical wound with local anaesthetic solution. This technique has been reported before *(1–3)* with satisfactory results but has not become popular. The relative safety of bupivacaine (Marcain) and the introduction of disposable bacteriological filters now make it possible once more to study the feasibility of such a technique.

Method

A pilot study and then a formal double blind trial was designed to investigate the effectiveness and safety of direct wound perfusion. Ten patients undergoing elective cholecystectomy participated in a pilot study. Postoperative opiate analgesic requirements were found to be greatly reduced in patients whose wounds were perfused with bupivacaine. No complications or side effects whatsoever were encountered and the surgical wounds healed normally. Details of technique were standardised and incorporated into the following double blind trial.

OPERATION AND ANAESTHETIC

The investigation was confined to patients undergoing simple, elective cholecystectomy through a Kocher subcostal incision. Patients who were found to require additional procedures such as exploration of the common bile duct were excluded from this trial. It proved impossible to formally standardise every aspect of anaesthetic technique but in practice there were very few differences. Nine out of ten patients from each group received an opiate premedication and, with one exception, every patient was given papaveretum or fentanyl during the procedure. Endotracheal intubation and assisted ventilation (using a non-depolarising muscle relaxant) was employed in every case.

No topical antiseptics or antibiotics were used during wound closure. Patients requiring nasogastric intubation were excluded from the trial. Papaveretum by intramuscular injection was the only opiate analgesic used for postoperative pain relief.

TECHNIQUE OF PERFUSION

At the end of the operation a Redivac suction catheter was positioned to lie in a plane between the peritoneum and muscle along the entire length of the wound (leaving via a separate stab incision). A Swinnes 12 millipore filter unit was then attached to the catheter using a 2 cm length of Redivac suction tubing and the rubber Redivac connector. The wound closure was then completed using monofilament nylon to the rectus sheath and interrupted silk for skin. A sheet of Op-Site was then applied as an adhesive transparent dressing to permit inspection of the wound. Finally a 10 ml loading dose of solution (bupivacaine 0·5% or placebo) was injected into the system before the patient left the operating theatre. Thereafter 10 ml bupivacaine 0.5% (or placebo) were injected into the system as a bolus at 4-hourly intervals until midnight of the day of operation, and then for a further 48 hours.

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The Editor would welcome any comments on this paper by readers

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TABLE I *Patient characteristics*

Group	*Number of patients*	*Males*	*Mean age (years)*	*Mean wt (kg)*	*Smokers*
Control	10	2	49.4	63.4	2
Intermittent bupivacaine perfusion	10	1	50.5	67.1	1
Placebo: intermittent saline perfusion	9	3	58.8	63.7	2
Continuous bupivacaine perfusion	10	4	49.0	70.4	3

There were no significant differences in mean age and mean weight between groups.

TABLE II *Pre- and postoperative measurements of vital capacity*

Group	*Mean pre-op. vital capacity (litres)*	*Mean vital capacity expressed as a percentage of the preoperative figure*		
		First postop. day	*Second postop. day*	*Fifth postop. day*
Control	3.53	37.2%	49.3%	72.9%
Intermittent bupivacaine perfusion	3.06	40.8%	53.0%	72.6%
Placebo: Isotonic saline intermittent perfusion	2.58	50.8%	64.1%	78.0%
Continuous bupivacaine perfusion	3.31	42.0%	56.0%	76.2%

There were no statistically significant differences in preoperative vital capacity between the groups. Likewise there were no significant differences in the values obtained on the first, second, and fifth days after operation.

ALLOCATION OF PATIENTS

Patients admitted for elective cholecystectomy, who gave informed consent, were randomly allocated to one of three groups:

(a) Ten patients acted as controls, i.e. no wound perfusion; intramuscular injections of papaveretum were administered on demand.
(b) Ten patients underwent intermittent wound perfusion with bupivacaine (plus papaveretum on demand).
(c) Ten patients underwent intermittent wound perfusion with a placebo solution (isotonic saline) and they too were given intramuscular papaveretum on demand.

The bupivacaine and isotonic saline placebo were supplied by the hospital pharmacist in individually coded packs of identical ampoules. The nature of the perfusion solution was concealed from the patient and from the nursing and medical staf involved in the trial. The double blind element was abandoned in a fourth group of patients who underwent continuous wound perfusion (bupivacaine 0.5%, 20 ml in 12 hours) using a clockwork syringe pump.

Throughout the trial it was stressed to patients and nursing staff that wound perfusion might not confer any relief of pain and that conventional analgesia, in this case papaveretum, should be administered whenever necessary.

Results

Total postoperative opiate analgesic requirements and vital capacities were measured. The chest was examined daily for evidence of infection and the wound was inspected daily, also for evidence of infection. The fourth group of 10 patients who received continuous wound perfusion with bupivacaine were studied after the double blind trial was completed. The data derived from this group are included in the tables for comparison. The information relating to one patient in the placebo group is missing, and this group, therefore, consists of 9 patients. Student *t* statistical analysis was applied to the results where appropriate.

The details of patient characteristics are given in Table I. Table II shows the mean preoperative vital capacity and the reduction (expressed as a percentage of the preoperative value) following surgery. The fall in the vital capacity seen postoperatively in the control and the placebo groups was also seen in those patients whose wounds were perfused intermittently or continuously with bupivacaine, even when they reported complete relief of wound pain. The postoperative papaveretum requirements are expressed as the mean total dose for each group in Table III. Those patients receiving bupivacaine by intermittent infusion required significantly less papaveretum than those patients not perfused at all ($P<0.01$). The reduction in papaveretum requirement in patients receiving continuous bupivacaine perfusion also reached statistical significance ($P = 0.1$) but the analysis is complicated by the fact that 4 of the 10 patients in this group required no papaveretum at all. These results are therefore similar to those reported in the earlier studies by Lewis and Thompson *(1)*, Gerwig *et al (2)*, and Blades and Ford *(3)*. However, it was also found that those patients whose wounds were perfused with isotonic saline required significantly less papaveretum than the control group ($P = 0.01$). There was no such group of patients in these earlier studies. There were no problems with wound infection or delayed healing in any patient undergoing wound perfusion.

TABLE III *Papaveretum dosage in patients undergoing wound perfusion*

Group	*No. of patients in group*	*Papaveretum requirements mean total dose (mg)*	*No. of patients in each group who required no papaveretum*
Control (no perfusion)	10	72.9 (±11.4)	0
Bupivacaine perfusion (intermittent)	10	20.0 (±14.1)	2
Placebo: isotonic saline perfusion (intermittent)	9	19.4 (±13.3)	1
Continuous bupivacaine perfusion	10	26.5 (±25.9)	4

The reduction in dosage in the intermittent bupivacaine and placebo groups was highly significant ($P<0.01$). Only 6 patients in the continuous bupivacaine perfusion group required papaveretum—the reduction in dosage just reached levels of significance ($P = 0.1$) (Student t test).

Discussion

Progress in the relief of postoperative pain has been slow and unimpressive in comparison with the advances made in other areas of surgery and anaesthesia. For very many years the mainstay of therapy has been morphine or similar narcotic analgesics. Such agents lack specificity both in the site and the nature of their activity and the price of adequate relief of pain is often an unacceptable degree of central nervous system depression. There is evidence that it is possible to overcome some of the objections to the use of opiates by varying the route and rate of administration and by tailoring the analgesic regimen to the individual patient. At its most sophisticated this technique involves the use of a computerised variable rate infusion pump which supplies intravenous fentanyl *(4)* on demand. Much of this research emanates from academic departments of anaesthesia and it is difficult to see how it could be extended on a wide scale to every district hospital in the country. It appears, therefore, that there is a place for some uncomplicated form of regional or local anaesthetic which might replace centrally acting agents or facilitate reduction in their dosage to very safe levels. With the exception of caudal injections these various forms of regional anaesthesia have not been adopted on a wide scale in general surgery. The most likely explanation is the degree of anaesthetic expertise and man power required not only for the initiation of analgesia but also for its supervision and continuing administration. A theoretical alternative to nerve block is the direct infiltration of the surgical wound with local anaesthetic.

Our clinical impression and the results of the uncontrolled pilot study have been borne out by the mean reduction of papaveretum dosage of over 70% where wounds are locally perfused with bupivacaine. The results of the controlled trial suggest that this technique of bupivacaine wound perfusion effectively reduces postoperative pain. However, it appears that normal saline is equally effective. These findings are most readily explained in one of the following ways:

(1) Bupivacaine perfusion is ineffective and any reduction in opiate dosage is merely a reflection of a powerful placebo effect and a tendency on the part of the nursing staff to withhold analgesia from patients undergoing wound perfusion.

(2) Bupivacaine is effective in this situation but calculation of analgesic dosage is an insensitive method of quantifying pain and pain relief since it relies too heavily on the nurse's assessment of pain and other factors such as levels of ward staffing. Pain score analysis and the mapping of areas of cutaneous analgesia in the region of the incision might distinguish more accurately between bupivacaine and a placebo.

(3) Perfusion of a surgical wound with normal saline may actually be therapeutic and not simply a placebo manoeuvre. It is conceivable that irrigation of the wound removes certain humoral agents such as histamine or vaso-active polypeptides which are implicated in the genesis of postoperative pain. This last possibility merits further investigation.

Neither bupivacaine by intermittent or continuous perfusion, nor intermittent saline perfusion influenced the dramatic fall in vital capacity seen following surgery, even when patients reported total relief of wound pain. In this study there were no statistically significant differences between the four groups.

The patients receiving papaveretum on demand experienced a fall to 37% of their preoperative value on the first day after operation. This figure rose to 49% and 73% on the second and fifth days respectively. Alexander *et al (5)* reported very similar results (39%, 45%, and 76%) in patients receiving intramuscular morphine on demand following gastric surgery performed through a right upper paramedian incision. There was no statistically significant improvement when the morphine was given by regular intramuscular injection. In a comparative study of morphine on demand versus epidural anaesthesia, Spence and Smith *(6)* found the same drop in vital capacity following gastric surgery, and again the method of analgesia did not affect the results.

It is commonly assumed that pain and spasm of the abdominal wall musculature results in impairment of ventilatory function but this may be an oversimplification. Certainly we encountered many patients who were comfortable and whose wounds seemed adequately anaesthetised but whose vital capacity was, nevertheless, greatly reduced. Perhaps peritoneal irritation of the under-surface of the diaphragm with resultant spasm and limitation of excursion is a more important factor, and may not always correspond to the subjective degree of postoperative pain.

On theoretical grounds one might expect wound irrigation to interfere with fibroblast activity and other factors involved in the early stages of wound healing. One of the conclusive factors to emerge from this study is that wounds perfused with bupivacaine healed normally. For the purposes of standardisation

the trial was confined to a single, clean surgical procedure. The absence of any complications of healing encourage us to extend the use of the technique to potentially contaminated incisions such as those used for colonic surgery.

Conclusion

The technique described of direct anaesthetic perfusion of a surgical wound is a useful model which is both simple and safe; there were no complications related to toxicity, hypersensitivity, infection, or impaired wound healing. It is our clinical impression that postoperative pain is greatly reduced by bupivacaine wound perfusion but the limited double blind trial demonstrated that isotonic saline placebo was equally effective. This result may represent inaccurate clinical impression, faults in the design of the trial, or a true therapeutic effect attributable to removal or dilution of pain mediating substances in the wound.

We intend to use bupivacaine wound perfusion for patients in whom opiate postoperative analgesia is contraindicated. Sophisticated assessment of pain is a difficult task in a district hospital but this technique does merit further investigations and a more detailed long-term trial is planned since a simple effective technique of specific wound anaesthesia would have widespread application.

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Notes on books

Correlative Neuroanatomy and Functional Neurology by J G Chusid. 476 pages, illustrated. 18th Edition. Paperback. Lange Medical, Los Altos. $15.

This book brings together the anatomical and functional features of the nervous system as they relate to problems encountered in clinical neurology. It is well illustrated with line drawings and charts, concisely written, and at the end contains references for further reading.

Anaesthesia in Patients with Ischaemic Heart Disease by D C Chung. 178 pages, illustrated. Edward Arnold, London. £14.

This is number 6 in the Current Topics. Dr Chung from London, Canada, identifies patients especially at risk and displays the modern methods of protecting the ischaemic myocardium by lowering the blood pressure, depressing the myocardium but improving the systemic circulation of the patient. He considers the drugs available to treat myocardial ischaemia, arrhythmias and congestive heart failure. He also considers the value of monitoring devices.

Injuries in Sport by D S Muckle. 159 pages, illustrated. 2nd Edition. Wright PSG, Bristol. £9.

This useful little book is intended for use in general practice and in an accident department. It considers the most frequent sites of injury, the immediate care and management of soft tissue injuries. The remainder of the book is devoted to a consideration of injuries in different parts of the body. It ends with a list of references for further reading.

Lymphatics of the Heart by A J Miller. 382 pages, illustrated. Raven Press, New York. $62.56.

The author is Professor of Clinical Medicine at North Western University Medical School in Chicago. It is always a pleasure to see a book prepared with loving care by the author who has obviously devoted many years of study to its preparation. Dr Miller offers a scholarly text on this subject starting with a review of the history of our knowledge of lymphatics of the heart, going on to deal with the anatomy, and the implications of disease of the lymphatics of the heart.

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